WHH/EAB

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AGRICULTURAL MEMORANDUM NO.323

Some notes on the attempt to find relationships between weather and mildew percentage on Proctor spring barley

W H HOGG

1. Biological information. Dr D A Doling has supplied NIAB plot data for the percentage of mildew on the high nitrogen plots, taken at the 10/5/4 growth stage. The dates of emergence and earing were also given.

   The data refer to the following stations and periods:

Headley Hall (Tadcaster))	
Sutton Bonington)	1958-67
Cambridge)	
Drayton (Stratford-on-Avon)	1962-67

2. Meteorological information. Standard records from the agrometeorological (or climatological) stations at Stockbridge House (for Headley Hall), Sutton Bonington, Cambridge and Drayton. Daily values are available in manuscript and monthly summaries are published in the Monthly Weather Report. In addition, there are daily values of total radiation from Wellesbourne (for Drayton) and of total and diffuse radiation and of illumination from Cambridge.

3. General variation in mildew percentage

   3.1 There is considerable between-station variation. The 10 year averages (6 years at Drayton) are 3 at Cambridge, 4 at Sutton Bonington, 14 at Drayton (probably 20 or more over the 10 years) and 19 at Headley Hall.

   3.2 The between-year variation at the individual stations ranges from 0 or 0.1 to 50 at Headley Hall, 45 at Drayton, 12 at Sutton Bonington and 10 at Cambridge.

   3.3 A comparison of the annual values of mildew percentage in relation to duration of growth period showed no relationship.

   3.4 Each station showed high mildew frequencies in 1958 and 1964 (no data from Drayton in 1958). These 2 years show a distinct tendency at all stations to be cool, dull and wet in June. In view of the statements in 3.1 and 3.2 it must not be assumed that these years were necessarily bad mildew years at all stations. The values are relatively high for the individual stations.

4. Examination of meteorological data in relation to mildew percentage

   4.1 The period emergence-earing at the 4 stations over 10 years comprises the months April, May, June and some correlation with the general weather of these months is possible. Emergence may be late or earing may be early, but the May weather can effect host and/or pathogen and this could be the most important month.

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The elements rainfall, temperature and sunshine were examined, using the values of percentage of average for rainfall and sunshine, and departure from mean for temperature.

The following classification was used for the monthly values published in the Monthly Weather Report.

Classification of monthly weather

Symbol	Rain % of average	Temperature departure from mean, °C	Sunshine % of average
++	49 or less	+ 1.1 or more	131 or more
+	50 to 74	+ 0.6 to + 1.0	116 to 130
0	75 to 150	+ 0.5 to - 0.5	85 to 115
-	151 to 200	- 0.6 to - 1.0	84 to 70
--	201 or more	- 1.1 or more	69 or less

+ symbols are used for subnormal rainfall to avoid confusion as low rainfall will tend to occur with high sunshine and, less often, with high temperature.

The generalization of monthly weather based on this classification are given in Appendix I.

4.2 No clear picture emerged from the comparisons but the following tendencies are worth noting although they are certainly too tenuous to be considered for forecasting.

April — No relationship between mildew and temperature or sunshine. On the whole the years with higher mildew percentages are associated with years when the rainfall is about normal or less.

May — High mildew years sometimes occur when May weather is close to average (classification 000). Any deviation from this tends to be towards increasing drought, temperature and sunshine.

June — As in April, the high mildew years show no relationship with temperature or sunshine. They tend to occur in years when June is not very dry - it is more likely to be about average or wetter.

Two points should be emphasized concerning these tendencies. The first is that the distribution of the mildew values is such that the probability of the tendencies being due to chance is quite high. The second is that the tendencies are mainly one way; for example, in April there are years which have April rainfall about average or less but which are not high mildew years.

5. Radiation data. Daily values of total radiation at Cambridge have been analyzed for comparison with local mildew records and similar data for Wellesbourne have been used with the Drayton mildew records. The radiation data refers to the period earing-emergence.

5.1 Cambridge mildew

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
% mildew	10	0.1	10	1	0.1	1	5	1	1	5
Radiation mwh cm^{-2}	24.6	29.5	28.2	29.3	30.4	28.0	25.3	29.4	30.8	32.2

There is very little variation in the mildew percentage values, which also show no relationship with radiation.

An analysis of the pattern of weekly radiation in relation to mildew assessment was also negative.

5.2 Drayton mildew

Year	1962	1963	1964	1965	1966	1967
% mildew	0	25	45	10	1	5
Radiation mwh cm^{-2}	34.1	24.5	25.6	28.5	25.5	25.9

These figures show no definite relationship, but the fact that the outstandingly high year for radiation (1962) was without mildew may be important. However, this must be set against 1966 with virtually no mildew at the 10/5/2 stage in a year when radiation was quite low.

An analysis of the pattern of weekly radiation in relation to mildew assessment was also negative.

6. Soil moisture deficits. Water balance sheets have been estimated for each station in each season during the period earing to emergence. These were based on daily rainfall records and estimated values of potential transpiration. As no irrigation was practised the high values for soil moisture deficit (SMD) which occur in some years are overestimates and should be regarded as potential rather than actual values. They give a clear indication of the years when moisture stress was high. The results for individual stations are given below.

6.1 HEADLEY HALL, based on rainfall from CAWOOD

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Max. SMD in.	1.0	4.3	4.9	3.1	4.1	3.5	2.3	3.5	2.6	2.7
Final SMD in.	0.1	4.3	4.9	3.1	4.1	3.5	2.3	3.5	2.5	2.7
Approx periods (days) with SMD > 1 in.	0	37	43	33	28	35	40	33	23	14
> 2 in.	0	27	27	23	19	21	16	19	12	6
Mildew %	50	15	5	10	7	0.1	50	30	20	5

The 2 years with maximum mildew percentage occur in years of lowest moisture stress, as measured by maximum SMD but otherwise the relationship is indefinite.

6.2 SUTTON BONINGTON

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Max. SMD in.	1.7	5.3	3.9	4.1	4.9	3.9	2.3	3.3	3.7	2.8
Final SMD in.	1.7	5.3	3.9	4.1	4.9	3.7	1.5	2.9	3.3	2.8
Approx period (days) with SMD > 1 in.	49	40	39	31	37	35	32	29	35	15
> 2 in.	0	31	23	22	23	22	5	18	23	7
Mildew %	12	0.1	1	1	1	5	10	5	5	1

The two years of highest mildew assessment, 1958 and 1964, were the years of least moisture stress and 1959 was the year of lowest mildew assessment and greatest moisture stress.

6.3 CAMBRIDGE

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Max. SMD in.	1.9	4.3	4.4	4.0	4.7	3.5	2.7	2.2	3.7	2.2
Final SMD in.	0.6	4.2	4.4	4.0	4.7	3.5	2.3	2.2	3.7	2.2
Approx period (days) with SMD > 1 in	15	34	43	29	40	26	30	28	30	10
> 2 in.	0	25	31	20	18	17	15	4	16	2
Mildew %	10	0.1	10	1	0.1	1	5	1	1	5

The lowest mildew percentages 0.1, occur in years of considerable moisture stress. One year (1958) of high mildew occurs in a year of very low stress, but the other high mildew year (1960) is a season of high stress. In order to obtain an approximate relationship of high mildew with low moisture stress, 1960 and 1965 must be ignored.

6.4 DRAYTON

	1962	1963	1964	1965	1966	1967
Max. SMD in.	5.1	3.3	2.1	2.8	2.5	2.9
Final SMD in.	5.1	2.6	0.9	2.5	1.8	2.9
Approx period (days) with SMD > 1 in.	43	40	30	35	30	16
> 2 in.	24	28	2	17	18	8
Mildew %	0	25	45	10	1	5

The year of highest moisture stress has the lowest mildew % (1962) and the year of lowest stress has the highest mildew % (1964) but the other years do not fit well into this pattern, particularly 1966.

7. Discussion

7.1 Tapka (1951) has emphasized that infection of wheat may occur over a wide temperature range, 2°-30°C. Mildew in various small grains is more severe where the stand is thick and plants have developed a lush tender growth. It is also stated that nitrogenous fertilizers promote susceptibility, but all the plots considered in this examination had the same nitrogen treatment.

7.2 The following weather would encourage good growth in the field:

Adequate rainfall during periods when radiation was not sufficiently reduced to give dull cool weather.

Although para 4.2 does not demonstrate clear relationships between weather and mildew percentage, the trends for May and June do not contradict the suggestion above.

7.3 Comparison with the numerical values for radiation and moisture stress with mildew assessments would, if Tapka's statement is substantiated in the field, suggest low mildew in high radiation years and also in years of high moisture stress, and the reverse. The tendencies shown in paras 5 and 6 suggest some support for this but certainly not enough to postulate definite relationships.

7.4 A grave weakness in the biological data is that only one assessment of mildew is available in contrast to the wide range of weather data. It may well be that any relationships could best be investigated by considering the course of the disease over the season rather than on one assessment.

8. Conclusion. No definite relationships could be shown between weather and the mildew assessment at the 10/5/4 growth stage on Proctor spring barley, although the data are reasonably consistent with Tapka's suggestion that a lush tender growth encourages the disease.

9. Reference

Tapka V F 1951 Influence of pre-inoculation environment on the infection of barley and wheat by powdery mildew. Phytopathology 41, 622-30

Any comments or suggestions on this paper should be sent to the author.

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APPENDIX I

HEADLEY HALL

Date of emergence and earing; percentage mildew assessment at 10/5/2 growth stage. Generalizations of weather data from Stockbridge House Experimental Horticulture Station, Cawood.

		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Emergence		22/4	8/4	14/4	8/4	22/4	23/4	22/4	3/4	18/4	30/4
Earing		5/7	16/6	16/6	18/6	28/6	21/6	26/6	20/6	22/6	20/6
Mildew		50	15	5	10	7	0.1	50	30	20	5
April	R	++	0	++	0	0	0	+	0	-	+
	T	-	++	++	+	0	0	0	0	--	0
	S	0	0	0	-	0	-	0	0	--	0
May	R	0	++	++	+	0	+	++	+	0	--
	T	0	++	++	0	+	0	++	0	0	--
	S	0	+	0	0	0	0	+	0	+	-
June	R	-	+	++	+	++	-	0	+	0	0
	T	-	++	++	0	0	0	-	0	+	0
	S	--	+	+	0	0	0	-	0	-	++

SUTTON BONINGTON

Date of emergence and earing: percentage mildew assessment at 10/5/2 growth stage. Generalization of weather data.

		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Emergence		15/4	5/4	28/3	22/3	22/4	19/4	10/4	2/4	4/4	3/4
Earing		25/6	15/6	5/6	15/6	25/6	17/6	16/6	18/6	20/6	22/6
Mildew		12	0.1	1	1	1	5	10	5	5	1
April	R	++	0	+	-	0	0	0	0	--	+
	T	-	--	+	++	--	0	0	0	--	-
	S	0	0	0	--	0	-	--	0	-	--
May	R	0	++	+	++	+	++	+	0	0	--
	T	0	+	++	-	--	-	++	0	0	-
	S	0	+	0	0	-	0	0	0	+	0
June	R	--	+	-	+	++	-	-	-	-	++
	T	-	+	++	0	--	0	--	0	+	0
	S	--	+	++	+	0	0	-	0	0	0

CAMBRIDGE

Date of emergence and earing: percentage mildew assessment at 10/5/2 growth stage. Generalization of weather data.

		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Emergence		15/4	5/4	5/4	4/4	15/4	22/4	11/4	2/4	4/4	31/3
Earing		15/6	11/6	8/6	10/6	22/6	22/6	11/6	16/6	16/6	16/6
Mildew		10	0.1	10	1	0.1	1	5	1	1	5
April	R	+	0	++	0	0	0	0	0	0	0
	T	-	++	+	++	0	0	0	0	-	-
	S	0	0	+	--	0	-	-	-	--	0
May	R	0	++	+	+	0	0	++	0	0	--
	T	+	+	++	0	-	-	++	0	0	0
	S	0	+	0	0	-	0	0	0	0	0
June	R	--	0	-	0	++	0	--	0	-	0
	T	0	++	++	+	-	0	-	0	++	-
	S	-	+	+	+	++	0	-	0	0	0

DRAYTON EHF (STRATFORD ON AVON)

Date of emergence and earing: percentage mildew assessment at 10/5/2 growth stage. Generalization of weather data.

		1962	1963	1964	1965	1966	1967
Emergence		18/4	7/5	11/4	5/4	24/4	18/4
Earing		27/6	4/7	16/6	19/6	23/6	21/6
Mildew		0	25	45	10	1	5
April	R	0	0	0	0	--	+
	T	-	0	0	0	--	-
	S	0	-	-	-	--	-
May	R	0	0	+	0	0	-
	T	-	-	++	0	0	-
	S	0	0	0	0	+	0
June	R	++	0	0	0	0	+
	T	0	0	-	0	+	0
	S	+	0	-	0	0	0